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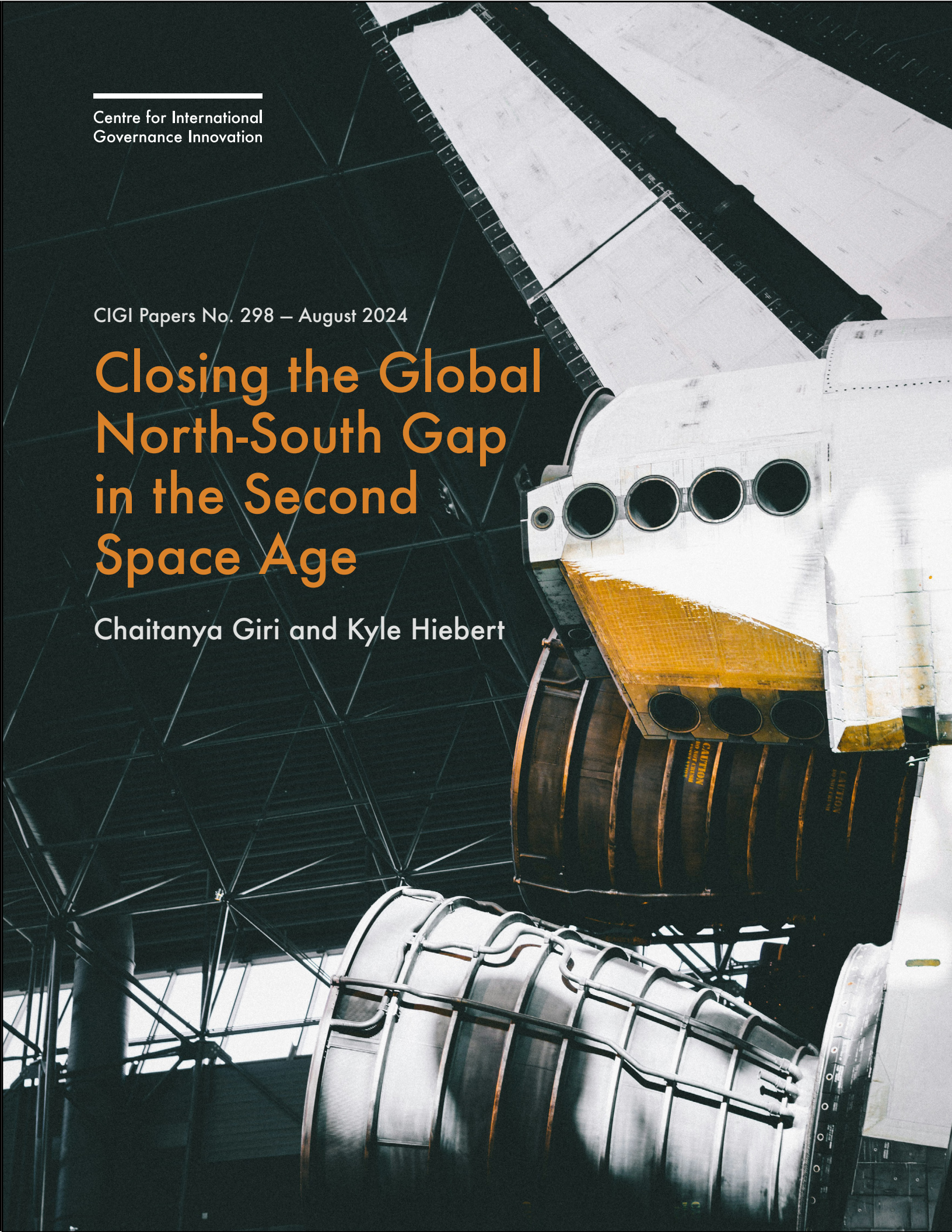

CIGI Papers No. 298 — August 2024

Closing the Global North-South Gap in the Second Space Age

Chaitanya Giri and Kyle Hiebert

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Table of Contents

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Acronyms and Abbreviations

CASC	China Aerospace Science and Technology Corporation
CASIC	China Aerospace Science and Industry Corporation
ESTEC	European Space Agency
FCC	Federal Communications Commission
G20	Group of Twenty
ILRS	International Lunar Research Station
ITU	International Telecommunication Union
MBRSC	Mohammed Bin Rashid Space Centre
NASA	National Aeronautics and Space Administration
NGSO	non-geostationary satellite orbit
NRO	National Reconnaissance Office
OST	Outer Space Treaty
PHI	Payload Hosting Initiative
UAE	United Arab Emirates
UNGA	United Nations General Assembly
UNOOSA	United Nations Office for Outer Space Affairs
ZARM	Center of Applied Space Technology and Microgravity

Executive Summary

When the world entered the first space age in the 1950s, only a few developed economies pursued access to space for their geostrategic goals. Over time, the global space apparatus began providing space applications to developing economies, helping them raise their socio-political indicators. Today, many nations of the Global South have recognized the significance of access to space and are investing efforts towards pursuing it. However, there is a stark divide between current and developing space powers, with the current powers creating astropolitical blocs based on the geostrategic space race that has waxed and waned but never diminished. This bloc formation burdens the developing space-capable countries with the geostrategic aspirations of the bloc leaders. In light of the fast-paced changes that space commercialization is bringing about worldwide, a new set of outer space regulations are needed under the auspices of the United Nations to narrow this Global North-South divide and ensure that access to space is equitable and benefits the inherent needs of human development and Earth's well-being.

Introduction

Humanity's dream of venturing into outer space was achieved during the first space age, which began with the Soviet Union's Sputnik moment in 1957 and ended in 2011, when the United States retired its Space Shuttle Program (Ionin 2014). But the benefits from humanity's forays into space during that period were concentrated among only a few nations. Indeed, a 1996 resolution adopted by the United Nations General Assembly (UNGA) tried to address this, declaring that the exploration and use of outer space should consider the benefits and interests of all countries, regardless of their levels of economic development or scientific capacities (United Nations 1996). The world is now on the cusp of a second space age — and this time it will be highly commercialized. Yet many societies, especially those in the Global South, are at risk of being excluded from the potentially enormous economic and technological gains of this new phase of space competition (Onder 2021). If this exclusion were to happen, it would represent a grave failure of multilateral diplomacy.

Incorporating more voices from developing economies in the nascent space initiatives now taking shape could strengthen the resilience of the global economy. It might also mend the fraying political ties and deepening distrust between industrialized and developing nations. Home to the bulk of the world's population and the vast majority of youths, nations in the Global South feel that they deserve a more equitable role within the international order. Financial institutions such as the International Monetary Fund and World Bank predict emerging markets in Asia and Sub-Saharan Africa will generally outpace the economic growth of most industrialized nations in the coming years. Moreover, the *World Population Prospects 2022* report from the UN Department of Economic and Social Affairs (Gaigbe-Togbe et al. 2022) projects that the Democratic Republic of the Democratic Republic of Congo, Egypt, Ethiopia, India, Nigeria, Pakistan, Tanzania and the Philippines alone will be home to half the global population by 2050. Harnessing such dynamism to raise living standards across the Global South — including the abilities of low- and middle-income countries to educate, train and enhance the productivity of their citizens using the latest space-based technologies — will therefore be vital to rebalancing the global economy (Kaul 2013): first, by creating a deeper pool of mobile, skilled labour to offset aging demographics in the Global North, which could also increase remittance flows by billions of dollars per year; and second, by generating new consumer markets, enhancing service delivery and facilitating the creation of novel industries in developing countries.

As a new space race unfolds, advanced economies including Canada, France, Japan, the United Kingdom and the United States retain a competitive edge in the burgeoning space economy, as do several of their European allies under the collective umbrella of the European Space Agency. Russia has historically been a dominant space power as well, though its national space agency, Roscosmos, has atrophied in recent years because of the loss of international partnerships and funding resulting from Western sanctions triggered by Moscow's illegal war in Ukraine (Skibba 2023). Many countries in the Global South are only now beginning to develop basic space capacities with assistance from the countries listed above. Looking ahead, new international agreements — in particular, the Artemis Accords established in late

2020 by the United States and its partners, and the International Lunar Research Station (ILRS) jointly planned by China and Russia — may create new opportunities for more countries from the Global South to participate in space exploration activities, which could involve either cislunar (moon-related) or interplanetary exploration pursuits. However, the focus of nations in the Global South will likely coalesce around space-related activities that gather and transmit data and improve the connectivity of their populations to help address developmental deficits.

Wealthier, more space-capable nations will therefore likely still wield greater power and influence when it comes to space resource utilization, be it in terms of harvesting extraterrestrial material resources or occupying orbital slots (Marino and Cheney 2023). Yet nations in the Global South still have a legal right to contribute to how these activities are governed. Article I of the Outer Space Treaty (OST) of 1966 — an agreement that all major space powers are party to and which underpins how international space law is determined — states: "Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies."[1] But there are complicating factors. The world is currently transitioning away from an era of US-led unipolar globalization to a more fractious multipolar order marked by economic nationalism, armed conflict and geopolitical rivalry. Without concerted effort, these same dynamics risk extending beyond Earth's skies and into space. Emergent space-related activities in the twenty-first century are also being profoundly shaped by the rise in commercial space activities worldwide, although mostly by private actors headquartered in countries in the Global North (Kaul 2023). It is thus becoming increasingly crucial that article I of the OST is updated, expanded upon and reflected in practice as the second space age gains pace.

With these issues in mind, this paper offers recommendations for how to ensure that space, even if it is not universally accessible, remains a peaceful domain used in a responsible way to benefit the development of all nations, not just a select few.

The Need to Redefine a Successful Space Program

There is a lingering perception among some, including tech billionaires and space entrepreneurs Elon Musk and Jeff Bezos, that rapid technological progress in spacefaring might enable humanity to populate the moon and, subsequently, Mars. From there, bases on both celestial bodies would become launch pads for long-duration space travel. But this concept is too linear and simplistic (Gunderson, Stuart and Petersen 2021). Policy makers and private companies are proving to be far more pragmatic by focusing on the possible economic returns from outer space activities, such as tourism, satellite communication technologies, resource extraction and more. This trend is generating broader mainstream interest around exploiting space, while also revealing numerous governance gaps. In turn, the number of stakeholders shifting their attention to the Earth's orbit is both increasing and diversifying, moving beyond the traditional set of actors, namely, state space agencies and their contractors.

Led by the United States, governments with mature space programs are trying to expedite revenue generation by allowing institutional investors and equity markets to partner with them on space activities that could prove lucrative in the future (Murray 2023). One interpretation of this trend is that governments in the Global North are trying to capitalize on the massive sums of taxpayer money that were spent during the first space age, when nation-states took a giant gamble and built up their space programs and technologies from scratch (Bland et al. 2022). This is rendering new space activities as mercantile — or, at least, motivated primarily by potential return on investment; by contrast, the first space age was fuelled by governments' desire to demonstrate technological supremacy in the ideological competition of the Cold War. For example, the US government has published explicit economic targets it hopes to achieve with its Moon-to-Mars initiative. In a document titled *Economic Growth and National Impacts of the Artemis Program,* the Office of

1 *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, 27 January 1967, Res 2222 (XXI) (entered into force 10 October 1967), online: <www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html>.

Technology, Policy & Strategy at the National Aeronautics and Space Administration (NASA) highlights the economic benefit of the 69,000 jobs the program is forecasted to produce over its lifespan (Besha 2022). It also aims to generate around US$14 billion in new fiscal spending as well as US$1.5 billion in combined added tax revenues at the local, state and federal levels. Although these projected amounts of money are small compared to those generated from other sectors of the American economy, they are still groundbreaking for being the first of their kind produced by an interplanetary exploration program.

China has likewise diversified its sources of space-sector financing by cultivating a mix of quasi-private venture capital firms and state-backed or state-owned commercial firms, such as the China Aerospace Science and Technology Corporation (CASC) and China Aerospace Science and Industry Corporation (CASIC). Chinese commercial space companies raised nearly US$6.5 billion between 2014 and 2021, while CASC and CASIC together earn a revenue of around US$35 billion annually (Euroconsult 2021). The country has also been a leader in encouraging its provincial governments to get involved in financing the space sector. Like US states that are keen to accrue the benefits from the Artemis program's revenue and creation of jobs, Chinese provinces are also making strategic investments in anticipation of reaping economic rewards from China's goal of becoming a pre-eminent space power (Liu et al. 2019).

Yet even with the emergence of private companies as increasingly active players in the second space age, the examples of China and the United States ultimately underscore that robust levels of public funding for space technologies are still necessary to drive technological development during the pre-commercial stage. To draw commercial interest and involvement into a national space sector also requires adopting pro-business policies to incentivize commercial space firms to invest in research and development activities that could give a host nation a competitive edge in space. It is therefore unrealistic to envision a future where access to outer space is truly egalitarian. Indeed, for the foreseeable future, China and the United States will be unrivalled in their capacities to make strategic investments into their space programs. Both countries are also unlikely to voluntarily curb their dominance of outer space simply out of deference to the common global good, as defined in article I of the OST and the 1996 UN Declaration on International Cooperation in the Exploration and Use of Outer Space.[2] In an increasingly multipolar world, the second space age is therefore likely to be influenced by elements of geopolitical realism, with nation-states competing on the basis of self-interest. This may include governments leveraging non-state actors in adversarial ways against their rivals. Nevertheless, despite these dynamics, it is crucial for both the global economy and international stability that countries aside from the world's club of industrialized nations and great powers are still able to equitably participate in — and benefit from — the second space age.

All countries seeking to participate in the second space age will bring with them their own unique blend of interests, perspectives, capabilities and challenges; each spacefaring nation will be in the position to develop best practices, which can serve as a catalyst for a more equitable and sustainable space environment when shared with others. China, Russia and the United States, along with other Western countries, have all achieved varying degrees of success with their space programs, as have India, Israel, the United Arab Emirates and others. However, it is not inconceivable that as other nations in Africa, Asia, Eastern Europe and Latin America grow their scientific capabilities and gain access to new technologies, these countries could produce even more innovative space programs than those currently in existence.

Until then, the most capable spacefaring countries will likely continue to dominate discussions on international regulations regarding outer space. This comes with an inherent risk that the second space age may fragment into rival blocs, based on the growing insistence by major space powers that emerging space participants align themselves with either the Artemis program, led by the United States, or the ILRS, co-led by China and Russia. In contrast, nations in the Global South have modelled a genuine embrace of universal access to space. This was evident in June 2022 at the deliberations of the 65th session of the UN Committee on the Peaceful Uses of Outer Space (UN 2022), which saw delegates from

2 *Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries*, GA Res 51/122, UNGAOR, 51st Sess, Suppl 49 (1996), online: <www.unoosa.org/oosa/oosadoc/data/resolutions/1996/ general_assembly_51st_session/ares51122.html>.

countries with nascent space programs focusing on preserving equal access to space — with the condition that such access remain dependent on the equitable and rational use of outer space for the benefit of all humankind. Delegates at this session also advocated that extraterrestrial resources should not be appropriated by any one nation or group of nations and that the militarization of space must be avoided.

The United Nations' Attempted Space Altruism

History has shown how fast a nation-state can both acquire and lose its competitive edge when it comes to space. While 200 years ago the United States was an agrarian society, with hardly any industrial or innovative capacity (Johnson 1997), it has evolved into a space faring global superpower. Conversely, Britain has neglected its space participation for decades, after first acquiring space access via Black Arrow launch vehicles from Woomera, Australia, in the 1960s during the twilight of the British Empire (Hill 2001). Today, the United Kingdom — once the world's dominant economic, technological and military entity — possesses a series of established spaceports, but uses these mostly to launch its satellites, along with those from Commonwealth countries and other European nations. These two examples of the United States and the United Kingdom illustrate that overall advantages in terms of space capability — and technological competition more broadly — are never inherent or static. The development and adoption of new technologies is a fluid process that depends on a range of ever-evolving factors. While many countries in the Global South today are considered space have-nots, this may not remain the case forever, especially given work currently being done by the United Nations' Office for Outer Space Affairs (UNOOSA), established in 1958 and headquartered in Vienna, Austria. One of UNOOSA's central mandates is to facilitate low- and middle-income countries' access to space science technology and help integrate space capabilities into their national development agendas.

Of particular importance is UNOOSA's ongoing "Access to Space for All" program. The international ratification of the OST produced a series of dedicated initiatives to create awareness about downstream (user-focused) applications of space-based technologies that could enhance capacity building across developing nations. In its early years, the legal instrument was realized through three United Nations Conferences on the Exploration and Peaceful Uses of Outer Space.[3] The first of the three, the UNISPACE-I Conference, was held in August 1968, which led to the establishment of the UN Programme on Space Applications. This program was tasked with organizing training courses, seminars, meetings and workshops to assist developing countries in acquiring skills regarding the use of space applications. Fourteen years later, UNISPACE-II enhanced the mandate of the UN Programme on Space Applications to facilitate ways for developing nations to share their space-related skill sets with each other. Finally, UNISPACE-III in July 1999 emphasized both the need and the opportunity to address regional and global issues affecting economic and social development using space technologies. A key aspect of this included recommending that developing economies be enabled to harness new and emerging space technologies, products and services for their social, cultural and economic progress.

Additional support for space-related cooperation within the Global South came from the UNGA Resolution 45/72, adopted in 1990. This resolution prompted UNOOSA's creation of regional training centres in developing nations with existing space programs to provide graduates and postgraduates from emerging economies with in-depth and long-term exposure to space applications.[4] A total of six regional centres have been established across the Global South over the past 28 years, the first being in India in 1995 — see Table 1 for details.[5] (This includes China establishing the Regional Centre for Space Science and Technology Education in Asia and the Pacific in 2014. While now considered an upper-middle income nation and home to the world's second largest economy, it is still formally classified by the United Nations as a developing nation.)

3 See www.unoosa.org/oosa/en/aboutus/history/unispace.html.

4 *International co-operation in the peaceful uses of outer space*, GA Res 45/72, UNGAOR, 45th Sess (1990).

5 See www.unoosa.org/oosa/en/ourwork/psa/regional-centres/index.html.

Table 1: UNOOSA's Space Outreach Activities in Various Regions of the Global South

Regional Centre	Year Established	Host Country	Participating Countries	Host Institution and Government
Centre for Space Science and Technology Education in Asia and the Pacific	1995	India	Bangladesh, Indonesia, Iran, Kazakhstan, Kyrgyzstan, Malaysia, Mongolia, Myanmar, Nauru, Nepal, Netherlands, North Korea, Philippines, South Korea, Sri Lanka, Thailand, Uzbekistan	Department of Space, India
African Regional Centre for Space Science and Technology Education — in French Language	1998	Morocco	Algeria, Benin, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, the Congo, Democratic Republic of Congo, Eswatini, Gabon, Guinea, Ivory Coast, Madagascar, Mali, Mauritania, Niger, Senegal, Togo, Tunisia	Morocco
African Regional Centre for Space Science and Technology Education — in English Language	1998	Nigeria	Botswana, Cameroon, Egypt, Ethiopia, Gambia, Ghana, Kenya, Lesotho, Liberia, Malawi, Sierra Leone, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe	National Space Research and Development Agency, Nigeria
Regional Centre for Space Science and Technology Education for Latin America and the Caribbean	2003	Mexico and Brazil	Argentina, Colombia, Cuba, Ecuador, Peru, Venezuela	National Institute of Astrophysics, Optics and Electronics, Mexico; National Institute for Space Research, Brazil
Regional Centre for Space Science and Technology Education for Western Asia	2012	Jordan	Egypt, Iraq, Kuwait, Lebanon, Libya, Oman, Palestine, Qatar, Sudan, Syria, UAE, Yemen	Higher Council for Science and Technology, Jordan
Regional Centre for Space Science and Technology Education in Asia and the Pacific	2014	China	Algeria, Argentina, Bangladesh, Bolivia, Brazil, China, Indonesia, Pakistan, Peru, Venezuela	Beihang University, People's Republic of China

Source: www.unoosa.org/oosa/en/ourwork/psa/regional-centres/index.html.

UNOOSA then established the Access to Space for All initiative in 2018. By collaborating with various mature space agencies, industry actors and research institutions, this initiative has provided developing nations with previously unattainable knowledge and training in space exploration and satellite development.[6] For students, the program has provided instruction through numerous online webinars and workshops. It has also offered in-person fellowships with institutions such as Japan's Kyushu Institute of Technology, which is well-known for assisting academic and research institutions in developing nations with constructing cube satellites, while also offering postgraduate courses and training for instructors (Polansky and Cho 2016). For institutions from developing economies, Access to Space for All has enabled them to deploy cube satellites into outer space — something that is impossible for them to do within their own countries at the moment. The program likewise enables access to cutting-edge hypergravity and microgravity facilities by sponsoring

6 See www.unoosa.org/oosa/en/ourwork/access2space4all/index.html.

Table 2: UN's Global Outreach for Promoting Space Science and Technology under the UN Access to Space for All

UN Access to Space for All Tracks	Goal	Project and Lead Institution
Space Exploration	Broadening engagement in space exploration Hands-on engagement opportunities in ongoing space exploration missions Open-source tools that bridge education components with hands-on training Creating education material for space exploration	ISONScope led by Keldysh Institute of Applied Mathematics, Russia (provision of small 20 cm aperture telescope with accessories and training module; winners get opportunity to join International Scientific Optical Network)
Satellite Development	Capacity building that enables operations, deployment and development of satellites Hands-on engagement opportunities in satellite deployment Open-source tools that bridge education components with hands-on training Creating education material for the entire life cycle of satellites	Payload Hosting Initiative (PHI) led by the Mohammed Bin Rashid Space Centre (MBRSC), UAE (deployment of 5U CubeSat payload on MBRSC's PHI-1 mission) KiboCube led by Japan Aerospace Exploration Agency, Japan (deployment of cubesat on the Kobo Module of the International Space Station) PHI led by the MBRSC, UAE (deployment of maximum 3U CubeSat payload on Avio's Vega C launcher)
Hypergravity and Microgravity	Hypergravity and microgravity capacity building for conducting on-orbit experiments Hands-on engagement opportunities in hypergravity and microgravity experimentation on ground and in orbit Open-source tools that bridge education components with hands-on training Creating education material for building experiments	DropTES led by the Center of Applied Space Technology and Microgravity (ZARM) and German Aerospace Center (access to ZARM's 146 m drop tower for conducting short-duration microgravity experiments) HyperGES led by the European Space Research Technology Centre (ESTEC) (access to ESTEC's large diameter centrifuge for conducting short-duration hypergravity experiments) Bartolomeo led by Airbus Defence and Space (access to Bartolomeo External Platform on the International Space Station for deploying a maximum 3U payload) Dream Chaser led by Sierra Space (deployment of experiments, satellites or payloads on Sierra Space's Dream Chaser spaceplane under development) China Space Station led by the China Manned Space Agency (access to the Chinese Space Station for space-based experiments)

Source: www.unoosa.org/oosa/en/ourwork/access2space4all/index.html.

their placement in low- and middle-income nations, therefore bypassing the large amount of investment that would otherwise be required by host governments to build them. Finally, the initiative has offered institutions in developing economies access to world-class education in space exploration and advanced telescopes for astronomy lessons (see Table 2 for details).

UNOOSA has also contributed in various ways to other UN-led global development initiatives, such as the Sustainable Development Goals and the UN's Agenda 2030. Development activities overseen by the agency — for example, the Benefits of Space for Humankind Program, the Space Law for New Space Actors, the Space for Persons with Disabilities, Space4Women, Space4Youth and Space4Water programs — each attempt to address a particular development issue through a paradigm of expanding space-based activities. These happen in conjunction with partner organizations that share the goal of supporting universal access to space — the Group on Earth Observations, the Committee on Earth Observing Satellites, the International Telecommunication Union (ITU) and the Committee on Space Research, among others.

Yet the goal of achieving universal access to space is running into an escalating number of challenges. The largest is arguably the way in which commercial efforts in space are oriented around and driven by bilateral activities among blocs of select countries bound together by shared political and economic interests. Given how the OST and subsequent UN resolutions have called for space to be preserved as a form of global commons, governance decisions related to its commercialization should instead be following consensus-based, multilateral decision-making processes in global fora. That way all nation-states, as well as civil society groups, can have their voices heard and needs recognized within deliberations on how to proceed with the second space age.

Politics as a Barrier to Universal Access to Outer Space

One prominent hallmark of the second space age now unfolding is that more countries have access to outer space thanks to the proliferation of commercial space launch capabilities. According to some estimates, there are at least 100 private launch service providers in the world[7] and more than 10,000 space-focused companies globally (Koetsier 2021). What this means is that nation-states can now establish their own space programs despite the fact that they lack their own means of domestically building and launching satellites into orbit. Such national space programs dependent on commercial actors have achieved various degrees of success, with outcomes mainly determined by the strength of their economies, the visions of their leadership and their national security status. Australia, Luxembourg, New Zealand and the UAE have created upstart space programs with advanced satellite and spacecraft capabilities in a relatively short amount of time. By contrast, Costa Rica, El Salvador, Kenya, Rwanda, Turkmenistan, Uganda and Uruguay are more narrowly focused on achieving small satellite capabilities. Political fault lines are already emerging: among newly established space agencies throughout the Global South, Colombia, Mexico, Nigeria, Rwanda and Uganda have signed up to the US-led Artemis Accords. Bangladesh, Mongolia, Peru and Thailand, meanwhile, have expressed interest in joining the Chinese and Russian-led ILRS.

Despite the theoretical altruism underscoring the principle of the universal access to space, geopolitical ties and national interests still prevail. These preferences are also liable to change over time as societies develop and evolve, or as leaders are forced to reckon with major paradigm-shifting crises, such as the war in Ukraine. This means that no government will likely ever voluntarily agree to completely unfettered universal access to space lest it yield competitive advantage to their rivals. Indeed, even the altruistic services enabled by UNOOSA have been limited to helping beneficiary countries who — out of self-interest — have first

7 See https://spacefund.com/launch-database/.

actively made investments in building up their own space programs (Oniosun and Klinger 2022). It is highly unlikely that any leading space power would ever attempt to cultivate space capacities in a partner nation if the latter did not first invest in its own development of indigenous space technologies and niche capabilities, as well as lay out short- and long-term strategies. Even if less space-capable countries invest wisely and achieve a modicum of success, great powers will always be motivated to retain techno-political control of outer space, as in any other realm of international competition. Space cooperation thus operates on a principle of "least function," in which the hierarchical sharing of information and know-how from dominant players is configured to provide only limited capabilities to their less powerful partners. Moreover, when it comes to arms control in outer space, as enshrined in the OST, information sharing around possible space-based weapons is expressly restricted or prohibited (Lele 2019). Although initiatives led by UNOOSA have helped broaden access to space to a certain degree, achieving true universal access remains a pipe dream. Politics will always play a major role in being an arbiter of access to space technologies and services, as reflected by the Artemis Accords and the ILRS. Both initiatives are rhetorically open to all countries interested in participating in them, in the spirit of the OST. But nations not otherwise broadly aligned with the United States or China and Russia have not been invited to join either program. The seeds of this bifurcation were arguably sown by the 2011 Wolf Amendment passed by the United States Congress, a piece of legislation that prevents NASA from engaging in bilateral cooperation with Chinese government entities or benefiting from the use of Chinese funds. Passing such exclusionary legislation that prevents one country's space agency from working with that of another nation-state is one method of restricting access to space. This underscores how space is no different from any other contested domain, where countries usually gravitate toward working with allies or partners with whom they share short-term interests.

NASA's Designated Countries List is another example of restricting access to space. The list contains countries with which the United States has no diplomatic relations as well as those under sanction by the US government. The list also includes those countries determined to be state sponsors or supporters of terrorism and nations of concern when it comes to developing certain missile technologies that could play a role in arms proliferation. Individuals from these countries are either denied entry to America's space agency or they must go through an extensive vetting process in order to do so. Any mail correspondence from NASA to these countries must also first be reviewed and cleared by a US government monitor. In turn, many governments of these designated countries have taken similar measures against the United States. Recent years have also seen global concerns surge over the possibility of widespread damage caused by anti-satellite cyberattacks from competing nations or non-state actors. In the future, such attacks could be motivated by a desire to deny certain entities access to the benefits derived from the development and deployment of critical space technologies.

The case of Pakistan demonstrates how political agendas complicate the pursuit of achieving universal access to space. In 2018, Pakistan's government appealed to the United Nations for universal access to space on a non-discriminatory basis and irrespective of its relatively low levels of technical, scientific and economic development compared to the world's leading space powers. China has since considered bringing Pakistan into the fold of its joint ILRS project with Russia, enabling Pakistani astronauts to visit China's Tiangong space station, which was launched in 2021. Currently, Pakistani institutions may receive aid and assistance through UNOOSA under the Access to Space for All program. However, even as Pakistan's space program advances as a result of closer collaboration with China, it is likely Beijing will never gift Islamabad access to China's most cutting-edge technologies, given Pakistan's political reputation of offering a safe haven for terrorism (Wani 2023). The conceptual merits of enabling universal access to space are insufficient to override real-world concerns about the possibility of malicious non-state actors in countries of concern or known state-sponsors of terrorism exploiting access to space to cause acts of sabotage that could prove profoundly destabilizing on Earth. It begs the question of whether renewed support for universal access to space in the second space age is being used as a pretext by some opportunistic political actors who have no intention of ever fully following through on realizing the principle itself. Instead, they may be leveraging superficial support for universal access to space to appeal to countries in the Global South in order to assemble or strengthen new

political alliances within the emergent multipolar order. In an era of rapidly expanding access to Earth's orbit and beyond, it is doubtful if there are enough monitoring mechanisms to ensure that the increasing number of governments, multinational companies and non-state actors interested in space actually honour the established laws around its use.

Mechanisms for Differentiating Access in the Second Space Age

Ensuring access to space is a subjective concept with different possible meanings. It could mean the freedom to navigate the physical pathways of outer space, or to access the leading space capabilities. Or, at the very least, it could mean ensuring access to the bare minimum of space-related technologies. Alternatively, it could be interpreted to mean that even if a country does not directly participate in space activities, it is still provided with a degree of economic or developmental benefit from the countries that do. Most low- and middle-income nations may not require first-hand access to the Earth's orbit to immediately benefit from space; they instead seek the data sets, scientific knowledge and emerging technologies being produced by new space-related activity that can then be used to address domestic socio-economic challenges, such as improving digital connectivity or mitigating the fallout from climate change. Here, the regional centres created by UNOOSA have been successful in training countries in the Global South to make pragmatic use of downstream space-based services from available space-based assets. By contrast, access to hypergravity and microgravity infrastructure or space exploration knowledge may only sometimes serve these countries' needs.

Still, countries in the Global South should not be precluded from accessing cutting-edge space technologies and activities if they so desire. All nation-states want to derive the maximum benefits from outer space. However, there are limits to reaping these benefits when a government or population remains dependent on external actors for technological support and the transfer of sensitive or proprietary knowledge. When it comes to developing nations making rational demands from dominant space powers for help applying downstream, space-based products and services for peaceful and constructive purposes, every effort should be made to eliminate barriers to access. For example, when it comes to satellite communications, in 1961 the UNGA's Resolution 1721 (D) led to the INTELSAT Interim Agreements, which note that the technology "should be organised in such a way as to permit all peoples to have access to the global satellite system" (Jakhu 2005, 179). The 1976 Convention on the International Marine Satellite Organization subsequently adopted the same principle.[8]

Both of these agreements need to be updated to reflect the unfolding dynamics of the second space age. For instance, access to many space-based services is currently offered on a subscription basis, which some have argued is a form of price discrimination since it is subject to service availability in any particular country (Gabszewicz and Sonnac 1999). Another example is how high-resolution remote-sensing data sets are more costly than their low-resolution variants: once again, access is determined by the price point, irrespective of the affordability for the end user. Subscription-based services, in any format, therefore, do not align with objectives around achieving universal access. Discrimination in access can also occur as a result of government policy, typically in relation to national security priorities. In late 2021, America's National Reconnaissance Office (NRO), a unit of the United States Department of Defense, began working on an Electro-Optical Commercial Layer (NRO 2021). Once this layer is finished, the NRO — the United States government agency responsible for operating satellites and providing satellite imagery to the US intelligence community — will permanently curb the sale of government-owned geospatial data sets in the public domain; only government-approved clients will then be able to acquire these data sets. The use of SpaceX's Starlink satellite internet services in Ukraine since Russia's full invasion in February 2022 has also illustrated the growing influence commercial actors have on access to downstream applications of space technology. Early on in the conflict, after Russian bombardment had knocked much of Ukraine's telecoms infrastructure offline, SpaceX CEO and

8 See *Convention on the International Maritime Satellite Organization (INMARSAT) (with annex and Operating Agreement)* 3 September 1976, 1143 UNTS No 17948 (entered into force 16 July 1979).

founder Elon Musk decided to provide Starlink's services for free to enable Ukraine to defend itself against an existential threat from Russia. However, a year later, Musk decided to limit Starlink service to the country over his concerns that it was being used to plan offensive military operations.

All three of these scenarios — price discrimination, national security considerations and the decision-making whims of private actors — offer a glimpse of how user access to space-related technologies may be differentiated in the highly commercialized second space age. None of them are properly accounted for in existing international treaties around space use, which date back to the 1960s, a time when only a handful of countries had demonstrated space-access capabilities (Burke 2017). The fact that space activities have become a multiplayer arena presents a double-edged sword. Certain types of differentiation mechanisms will indeed prove to be discriminatory for the Global South. And yet, given mounting evidence of the operational, legal and political challenges in relation to the second space age, differentiation in access to space will become a practical necessity for upholding the principles of the OST.

Applying Space-Based Technologies toward Development Goals

Even more than gaining universal physical access to outer space, many developing nations seek to harness space-based technologies to close digital gaps to improve domestic health and educational levels as well as service delivery (Bhaskarnarayana et al. 2009). Take, for instance, the need to strengthen last-mile services — in other words, to enable the movement of people and goods from major network hubs to their final destinations. Most developing economies grapple with weak infrastructure that burdens this type of logistical activity. For citizens, inefficient transportation systems make commuting to work more difficult, thereby reducing living standards and preventing a given economy from achieving its true potential. Better information aids businesses to access valuable resources, generate new prospects and enter new markets. Likewise, more robust meteorological data can boost agricultural yields. Satellite communication enables medical assistance and educational curricula to better reach rural areas. To these ends, developing economies greatly benefit from access to user-ready remote-sensing data, digital connectivity and affordable, easy-to-deploy space-based services.

The use of space technologies, services and products by national governments to achieve their climate-related Sustainable Development Goals is proving especially valuable. Space-capable nations among the Group of Twenty (G20) have contributed at least US$650 million in overseas development assistance that incorporates space-based technology (Organisation for Economic Co-operation and Development 2021). This aid has supported the build-out of economic infrastructure, enhanced government service offerings, assisted the monitoring of ecosystems and natural resources and bolstered food security. As part of the 2022 Bali Declaration, G20 countries also requested that the UN Food and Agriculture Organization and the World Bank Group strengthen space-based data sets by sharing the results of their recent respective exercises to map out pathways to global food security. In particular, the declaration mentioned how this could contribute to developing the G20 Agricultural Market Information System, which one of this paper's authors has previously recommended building out further to include private sector actors (Giri, Kumar and Sethi 2022). The Agricultural Market Information System, which works closely with the intergovernmental Group on Earth Observations on the GEO Global Agricultural Monitoring mechanism, has provided geospatial products generated by public space agencies to enhance food security in various parts of the world. Commercial remote-sensing service providers should be engaged in mutually beneficial ways to contribute their data sets as well as to meet the same food security goals.

Similarly, governments at the local and national levels in emerging markets need to be better equipped to mitigate climate change and enhance emergency preparedness or handle the outbreak of conflict and its spillover effects, such as population displacement (Giri et al. 2023). Given their relatively low levels of infrastructure and development, these are risks faced disproportionately by developing nations (ibid.). But evidence shows that by using satellite

data-gathering and communications technology in order to map and monitor these emergencies and create responsive mechanisms, the impact of these events can be greatly reduced. According to the World Bank and the Global Facility for Disaster Reduction and Recovery, a global partnership focused on disaster risk reduction and climate change mitigation, when compared to the status quo, greater deployment of space technologies, products and services can contribute to building more resilient infrastructure globally that might eventually produce a net savings of around US$4.2 trillion on building resilient infrastructure, mostly in the Global South (Hallegatte, Rentschler and Rozenberg 2019). This is based on World Bank estimates that suggest a benefit-cost ratio of 4:1 — four dollars in socio-economic benefits are generated for each dollar spent on integrating relevant space-related technology into new infrastructure. Here again is another area where commercial companies will play a greater role in the second space age. As private sector space capabilities progress faster than those originating within national space programs, the data from commercial satellites will become ever more valuable for government use in mapping, monitoring and mitigating domestic vulnerabilities.

Providing more space-related overseas development assistance to the Global South would have reciprocal benefits for industrial nations as well. Many of the advanced economies within the G20 are experiencing a shortage in skilled labour in their space sectors, primarily due to aging populations. For example, the US Census Bureau found that in 2020, 36 percent of American workers were aged 50 or older (Kiersz 2021). The COVID-19 global pandemic aggravated this situation by driving a number of qualified workers with credentials in science, technology, engineering and mathematics (STEM) into retirement. At the same time, the disruptions caused during that period led to a historic drop in the number of STEM graduates and postgraduates produced by American universities (Langin 2022). The reduced economic growth rates anticipated for Europe and North America over the next decade, compared to those of the early years of the post-Cold War era, will also likely reduce the amount of funding that governments can use for expanding research and development initiatives and workforce training programs. This lack of funding could lead to a decrease in the types of job opportunities that for decades motivated skilled workers from the developing world to migrate to the Global North. It is true that established space contractors and their subsidiaries in industrialized nations will likely continue to be the dominant commercial space sector players for the foreseeable future. However, their manufacturing facilities and downstream services, which depend on the information technology sector, may eventually become concentrated in the younger, more dynamic Global South, where the cost of property and labour is substantially lower. Therefore, to revitalize the labour force within their own space sectors, industrialized nations with advanced space programs are beginning to prioritize public-private partnerships around the space sector as a part of their diplomatic outreach to developing nations.

Crowded Space: Orbital Slot Squatters and Harmful Interferences

Owing to the slower rate of progress made by space programs in the Global South and the relatively small number of satellites these countries operate, more space-capable nations already occupy more than their fair share of orbital slots — the designated spaces for satellites to position themselves. Many Global South countries are thus demanding revisions in the “first come, first served” principle used by the UN’s ITU to allocate orbital slots. In particular, calls to revise the 1975 United Nations Outer Space Regulatory Framework have been growing in the past few years, as the number of orbital slots available has been drastically reduced by a surge in commercial satellite launches, which is causing orbital congestion (Putro, Nugraha and Nugraha 2022).

However, resolving the challenge posed by the diminishing number of slots is more complex than it appears. Since the Global North has a flourishing private space sector, many satellite operators have adopted the practice of pre-emptively filing the paperwork to upgrade their satellite fleets well before new units are even manufactured, much less deployed. In essence, private companies have been securing orbital slots based on aspirational goals, rather than material needs. The ITU has tried to address this recently by discouraging the

paper filing process and reducing the period of time that a satellite can be placed in orbit (Sadat and Siegel 2022). Another major issue is the consequences of harmful interferences generated by a rapidly growing number of satellites operating in increasingly close proximity. This can degrade not only the radio communication service a satellite intends to provide to its users, but also the viability of an orbital slot itself. And while the ITU has tried its best to create a formal process by which nations and satellite operators can coordinate with each other to prevent harmful interferences, the agency lacks the enforcement power necessary to be more hands-on in managing radio communication frequencies (ITU 2022).

Unfortunately, much of the problem lies in the foundational treaties that UNOOSA supervises: all five space treaties under its purview omit the need to regulate Earth's orbit in order to provide equitable access for all nations. The term "orbit" appears in the OST just twice — and only does so in the context of prohibiting the placement of weapons of mass destruction in the Earth's orbit. The 1971 Liability Convention similarly does not mention the word orbit; instead, it focuses on how states are liable for any damages their satellites cause back on Earth.[9] In the Registration Convention of 1974, the only reference to orbit is in relation to the basic orbital parameters or pathways of a space object that must be registered with authorities — for example, the apogee, perigee, inclination and nodal period of a satellite. One bright spot is that the growing emphasis on space situational awareness and traffic management within space has led to the creation of various ad hoc mechanisms to ensure satellite safety by avoiding collisions. But all told, there remains an urgent need for more focus and engagement by multilateral and intergovernmental organizations to solve the tragedy of commons regarding orbital slots.

Countries with the most advanced space programs and their rising number of commercial space players can often come across as orbital squatters. Their evolving capacity to launch enormously large non-geostationary satellite orbit (NGSO) systems in the low-Earth orbit is very likely to cause interferences to geostationary (fixed orbit location) satellites (Braun et al. 2019). With more than four NGSO constellations, each with more than 10,000 satellites, already in various stages of deployment by both China and the United States, simple interference mitigation techniques that have been relied on in the past are becoming obsolete. To ensure the safety and function of all of the satellites in orbit — upon which the financial and communications technology of billions of people rely — concerted effort must be made at creating more stringent regulations to prevent an exponential spike in harmful interferences.

In a positive development, in September 2022 the US Federal Communications Commission (FCC) announced it would handle oversight of two of the new 10,000-strong NGSO satellite constellations being deployed. America's communications regulator also pledged to set a five-year deadline to decommission defunct satellites still floating in low-Earth orbit, particularly those belonging to private companies that will soon be launching additional satellites (FCC 2022). However, while this is certainly a constructive step, the FCC's decision can also be criticized as emerging out of a desire to prevent space debris, rather than as a proactive move to free up orbital slots for new entrants to space. In addition, since the FCC's announcement, key commercial players have applied for waivers to avoid having to bring their units back down to Earth. Private actors in space are also likely to appeal to national security interests as a supposed justification to squat in orbital slots, rather than make them available to new space participants from the Global South.

Arguments for more equitable access to orbital slots also gain currency when framed through a sustainability lens. Hardly the vast frontier it is often made out to be, the Earth's orbit is a finite realm and resource prone to degradation and congestion. Moreover, access to outer space is not merely physical in nature. The growing number of satellites in low-Earth orbit and higher has already reached a tipping point where their cumulative mass is distorting ground-based visibility of outer space, both through radio and visual interference. Even before the impending explosion in orbital activity set to take place in the second space age, satellite constellations have already contributed to as much as 10 percent of presumed natural background light levels at an observer's zenith (Kocifaj et al. 2021). This diffuse, unnatural night sky brightness has pushed light pollution around astronomical observatory sites past the limits set

9 *Convention on International Liability for Damage Caused by Space Objects*, 29 March 1972, Res 2777 (XXVI) (entered into force 1 September 1972), online: <www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/liability-convention.html>.

by the International Astronomical Union, posing a major threat to ground-based astronomy. Another lesser-known yet equally destabilizing consequence of orbital satellite congestion and its resulting radio interference is the increasing difficulty of maintaining precise time and meteorological measurements worldwide (Yang et al. 2023).

Conclusion

The global space economy is poised to grow rapidly over the next two decades. But the inadequacy of existing space governance mechanisms, coupled with the growing geopolitical friction among space-capable nations, currently threatens the world's ability to ensure that the second space age is one that will be peaceful, sustainable, equitable and transparent. As space activities begin to play an increasing role within the global economy, generating enormous financial and strategic gains, it will become even harder for institutions to hold governments and private actors responsible for their behaviour in Earth's orbits. Developing nations will not be able to match the space capabilities that the current great powers have, at least not in the near future. But not all countries need to possess advanced space programs, or have universal access to Earth's orbit, for the second space age to be rendered much more equitable than the first.

Indeed, the growing space interests and political clout of nations throughout the Global South are delivering a helpful dose of new energy and urgency to efforts to reform international space governance laws and institutions. Some aspiring space participants in the Global South are bound to become leaders in developing best practices in sustainably deploying and operating space technologies, products and services; their populations should be assisted with acquiring the requisite technology, knowledge and skills to do so. At the same time, the inclusion of more developing nations within the emerging astro-political blocs being assembled by leading global powers should act as a counterbalance to the hawkish tendencies of their founders.

A central focus amid all these dynamics should be coordinating diplomacy and multilateral engagement around overhauling the OST. None of the treaty's constituent conventions in their present form can ensure sustainable, equitable and just activities in Earth's orbits. They also lack mechanisms to regulate commercial actors and hold them accountable in any meaningful way. The stark absence of legally binding regulations to prevent a handful of leading space powers to benefit from the status quo of orbital squatting must be addressed. The practice of allocating orbital slots based on a first come, first served basis must be repealed. This will enable more countries from the Global South to launch and operate small satellites in space capable of delivering them vital space-based services that can aid their populations in socio-economic development, security and climate mitigation. If orbital squatting is left unattended, worldwide vulnerabilities related to excessive light pollution, wayward radio interferences and proliferating amounts of space debris will only get worse.

Amid the rapid growth and changes now occurring within the global space economy — especially the progress being made by industrialized nations — it has become increasingly important to amend and contemporize norms, laws and regulations governing outer space. In short, they must be made more accommodative of the rising aspirations of the Global South. To ensure such changes have lasting effect will require concerted diplomatic effort to develop these regulations through international fora that include actors from across the political and economic spectrums. The alternative — failing to reach a consensus or allowing influential spacefaring countries to shape the second space age into a hostile bipolar contest — will inevitably lead to terrestrial conflicts spilling over into outer space. Such a situation would negatively affect all of humanity and must be avoided at any cost.

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